MEDDELELSER OM GRØNLAND
UDGIVNE AF
KOMMISSIONEN FOR VIDENSKABELIGE UNDERSØGELSER I GRØNLAND
BD. 107 · NR. 2

6. OG 7. THULE-EXPEDITION TIL SYDØSTGRØNLAND 1931—33
LEADER: KNUD RASMUSSEN

TIDAL OBSERVATIONS

MADE AT

NANORTALIK AND JULIANEHAAB
IN 1932–1934

A. WORKS IN FIELD

BY C. C. A. GABEL-JØRGENSEN

B. RESULTS FROM TIDAL OBSERVATIONS MADE IN SOUTH-GREENLAND

BY J. EGEDAL

WITH 12 FIGURES IN THE TEXT

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI A/S
1940

UDGIVET MED STØTTE AF CARLSBERGFONDET

PREFACE

An account of the Tidal Observations made on the 7th Thule Expedition is contained in the following.

These investigations which were commenced in 1932, were continued up to the summer of 1934 that is, long after the conclusion of the said expedition and also, therefore, after the death of Dr. Knud Rasmussen.

In the working out and publication of the Expedition's remaining Geodetic material, the Tidal Observations, the cost of which was entirely defrayed by the Thule Station, were also entrusted to the Geodetic Institute, Copenhagen.

By reason of the great consideration shown by the Director of the Institute, Professor N. E. Nørlund, Dr. phil., this special work appears in "Meddelelser om Grønland". At the request of the Expedition the Institute handed over the material concerning the Tidal Observations to the Meteorological Institute, Copenhagen, and this was again handed over by the Chief of the Institute, Director Dan la Cour to J. Egedal Esq., B. Sc., State Meteorologist and Chief of the Institute's Geophysical Section, for scientific adaptation.

In the ensuing, the writer, who was leader of the Geodetic operations of the Expedition, accounts for the observations and for all the works in the field, while State Meteorologist J. Egedal Esq., gives a deducing of the results, and also accounts for their relation to previous Tidal Observations in Greenland.

All the photographs were taken on the 7th Thule Expedition.

I wish to express my thanks to the Station of Thule, whose Administrator at that time, Rudolf Sand Esq., Barrister-at-Law allowed me to complete the work, also after the death of Dr. Knud Rasmussen; to the two Chiefs of Institutions, Director and Professor N. E. Nørlund and Director Dan la Cour for the great interest they have shown this work, and finally my thanks to J. Egedal Esq., State Meteorologist, for excellent collaboration and for the whole of his efforts in this matter.

Korsør, *1st August 1940.* GABEL-JØRGENSEN.

A. WORKS IN FIELD

BY

C. C. A. GABEL-JØRGENSEN

I. Introduction.

The main task of the 7th Thule Expedition was on the South East Coast of Greenland.

During the stay at Julianehaab, the Head Base of the Expedition, before and after the journeys to East Greenland, a number of Geodetic measurings and investigations were made, under which were the Tidal Observations in Nanortalik and Julianehaab[1]), treated in the following.

This more secondary task has, however, attained special importance inasmuch as it has thereby been partly successful—in relation to older investigations—to obtain a sure value for the sinking of South-Greenland (Nanortalik district), and that, for the first time in Greenland, measurings have been partly carried out with an Automatic Recording Tide-Gauge, by means of which very exact values have been obtained for tidal harmonic constants and for mean sea level measured in proportion to fixed points on land.

The origin of these measurements is as follows:—

On the journey southwards with the Geodetic Team in 1932, Nanortalik was passed on the 5th of July and I paid a visit to Holm and Garde's old observation place, just south by the harbour. It then struck me that the time was opportune to renew Tidal measurements from the same fixed point in land, as it must be considered that the past approximate 48 years was a suitable lapse of time to enable one to safely give an opinion concerning the extent and sign of the vertical movement of the earth's crust.

The fundamental measurings were made by Naval Lieuts. G. F. Holm and T. V. Garde who also started tidal measurings in Nanortalik on the Danish "Woman's Boat" Expedition to East Greenland of 1883.

In his report on the matter: "Den østgrønlandske Expedition", made in the years 1883—1885 (Medd. om Grønl. Vol. 9) the Leader G. F. Holm writes on page 70 the following:—

> "The tidal measurings were undertaken by the hands every tenth minute in the course of an hour and a half about the high and low

[1]) C. C. A. Gabel-Jørgensen: Report on the Expedition. Medd. om Grønl. Vol. 106, No. 1, pp. 91 and 183.

water which occurred between 5 a.m. and 10 p.m. The hands carried out these intricate and often strenuous observations with admirable attentiveness and exactness. The starting point for the tidal measurements is connected with a bench mark which is cast in the rock between the dwelling house and the Magnetic House for Variation Investigations.

This mark, consisting of an iron bolt which is cast in lead in a deep hole is at a height of 19.93[1]) feet over mean sea level. By means of this it will be possible to ascertain whether the land really sinks as generally maintained, when tidal measurings are again made at a later date."[2]).

---

[1]) Cfr. the found value by C. Crone of 20.07 feet given in Medd. om Gronl. Vol. 9, page 339 and the now deduced value in this treatise page 40.

[2]) Those who travel along the coasts of Greenland—once their attention has been drawn to the fact—will not fail to notice the traces of the changes of the sea level which have taken place through the ages.

At many places one discovers the greatly elevated coast line. At other places the ruins of Eskimo houses lie awash on the beach and clearly proclaim the sinking of the land.

The last-named is thus the case as regards the Cape Farvel district and is surely that, to which Gustav Holm refers in the quotation above.

For the further illumination of this question,—and in connection with the tidal observations dealt with in this treatise,—I have referred to Museum Inspector Therkel Mathiassen, Ph.D., whose reply I find so interesting that I have felt induced to repeat it here *in extenso:*—

"Observations Concerning the Vertical Movements of the Earth's Crust in Greenland.

During my archæological expeditions to Greenland in the years 1929—34, I continually made observations as to whether conclusions can be drawn from the present position of the older buildings, concerning the rising or sinking of the land since this building took place, as I have continually taken into comparison the factors in Hudson Bay—Baffin Land district where the situation of the ruins indicate that a continual and gradual rising of the land has taken place during the recent centuries[1]). In my various publications concerning the archæology of Greenland[2]), I have continually kept this state of affairs in view and also discussed it occasionally. I will endeavour here to give a concise recapitulated survey of these observations.

The investigations cover four districts on the West Coast and two on the East Coast viz. Upernivik District where 30 ruin places were visited, Diskobugten (50 ruin places visited), Sukkertoppen District (24 ruin places visited), Julianehaab District (137 ruin places visited) and on the East Coast, Angmagssalik District (95 ruin places visited) and a district of the southernmost East Coast, between Skjoldungen and Lindenows Fjord (22 ruin places visited). In all 258 ruin places have thus been visited in Greenland.

[1]) Archæology of the Central Eskimos. Report of the Fifth Thule Expedition IV. 1927, pp. 8, 129 and 226.

[2]) Medd. om Gronland Vols. 77, 91 No. 1 (see particularly p. 56), 92 No. 4 (see particularly p. 46), 93 No. 2, 109 No. 2 and 118 No. 1 (see particularly p. 86).

In Uperniviks District was in nine settlements found ruins, which by reason of the sinking of the land were partly broken down by the sea, or in any case now lay so low that the sea at high water washed up round about, or in them. Of these ruins, the three belong to the period of the 17th—18th century, while two belong to the first half of the 19th century. The other four had broken down ruins of an indefinable age. At the great settlement of Inugsuk was a ruin which is known to have still been occupied in 1857, now so low that with a sea-wind, the sea washed through the entrance-passage into the house while three other houses which had been occupied in the first half of the 19th century were broken down, so that only a part of the back wall and the one end wall remained.

Diskobugten. Partly washed away ruins of houses of 19 settlements are found here, and of these the thirteen are in any case from the 17th—18th century, while six are indefinable. At the settlement Nisat there is a house which was still occupied in 1811, with an entrance-passage partly swept away.

Sukkertoppens District. Here there are partly ruined houses at 5 settlements, and of these in any case four are from the 17th—18th century.

Julianehaabs District. At 39 ruin places, houses are seen which are being broken down by the sea, and of these, by far the greatest number (viz. 35) are also of the 17th—18th century square type, for the most big common houses, one is from the first half of the 19th century, while three others are indefinable. Some of the ruined houses have a part of, others the whole entrance passage, while others also have the front wall and a part of the side walls broken down.

Any actual difference in the subversive forces on the north and south West Coast cannot be proved, although there is a slight excess for North Greenland. If, for instance, one calculates the percentages of settlements with demolished ruins in proportion to the total number of ruin places visited, 30 % is obtained for Upernivik District, 38 % for Diskobugten, 21 % for Sukkertoppen District and 28 % for Julianehaab District. If these figures are calculated for the whole North and South Greenland, the result is 35 % and 27 % respectively. Neither is there any appreciable difference respecting the subversive forces as regards single ruins.

An important fact is that by far the greatest number of the ruins which are damaged by the sea are from the 17th—18th century, some few of them from the first half of the 19th century, but none of them appear to be older than the 17th century. Nowhere have there been found the little round-type houses of the Middle Ages, damaged by the sea. These lie either at a height above sea-level which now would seem to be suitable, or higher than it would be reasonable to place them now. The oldest ruins seen in West Greenland on the island Igdlutalik near Torssukátak Isfjord in Diskobugten now lie at a height of 2—6 metres over sea-level. Where there are found ruins of the oldest type, together with houses from the 17th—18th century, the last-named often lie lowest. At Igdlorssuit, near Qeqertaq (Diskobugten) which mainly consists of houses of the oldest type, the last occupied house (1794) lies the very lowest, so that the sea enters at the entrance-passage. At Ingik in Sukkertoppen District seven old round houses lie highest and below these six newer square houses, the lowest on the beach, similar conditions as at Ûmánaq south of Sukkertoppen. At the great ruin place Tugtutûp Isua in the Julianehaab District the most of the old round houses lie 4—9 metres above sea level while the square ones from the 18th century lie 3—4 metres above sea-level and a "tent-ring" which is scarcely older than the first half of the 19th century is now awash by the sea.

At Anordliuitsoq near Cape Farvel, the old round houses are lying 2—4 metres above sea-level, while four of the newer square ones are partly washed away. At

The bolt was easy to find and appeared to be quite unaffected by the ravages of time.

It therefore appeared that both the time was opportune and conditions present for the further carrying out of this special task, and the decision was quickly made. All the preparations had to be carried out in great haste, as everything of course had to be done to make it possible to get to the East Coast without delay, where the great task was awaiting. We had, furthermore, to manage with those materials which were obtainable in the Colony and also make use of Greenlanders as observers. But all this succeeded, and already the next day the Tidal observations were in operation and the journey to the East Coast could continue.

In the ensuing will be given a complete description of the whole of the starting of the work and the carrying out of the observations, extending as these did right up to July 1934, that is to say, after the close of the 7th Thule Expedition 1933.

Pernera in Lichtenau Fjord there is a little round ruin 3 metres above sea-level and down on the shore, a big ruin from the 18th century. It is the same at Perdlernerit near Julianehaab.

This state of affairs implies that the sinking which is now taking place along the West Coast first began about the 17th century, whilst previous to this time a rising had taken place. Traces of such an older rising can be seen at many places, the upper old houses at the Utorqait Settlement near Kangâmiut being built on an old sea beach containing sea shells.

The facts should therefore be that a rising of the land occurred after the Middle-Ages houses were built. On the land thereby raised by the sea were so built, in many cases, 17th—18th century houses which, according to the Eskimo custom were as near the sea as possible without, however, running the risk of flooding. With the subsequent sinking, these low-built houses have been partly broken down, while the sinking has not yet reached lower than the Middle-Ages (13th—15th century) sea level. It is difficult to say, in each particular case, to what extent the sinking must have been to have caused the breaking down of the houses in question. I am, however, of the opinion that 1—2 metres will be sufficient in most cases.

If we go to the East Coast, four settlements with partially ruined houses are to be found on the southernmost coast, i.e. a "demolition percentage" of 18. It is also houses from the 17th—18th century which have suffered everywhere here, while the older ones lie higher everywhere.

Tingmiarmiut is the northernmost place where house ruins damaged by the sea are seen.

In Angmagssalik District, nothing has been seen implying a sinking of the land since the building up, despite the fact that nearly all the settlements in the district have been visited. On the contrary, many houses lie remarkably high, but this is due rather to the state of the terrain or for strategic reasons than to a sinking of the land.

It cannot therefore be proved with certainty that any changes of sea level took place here since the first building (14th—15th century).

31 May, 1940. sign. THERKEL MATHIASSEN.

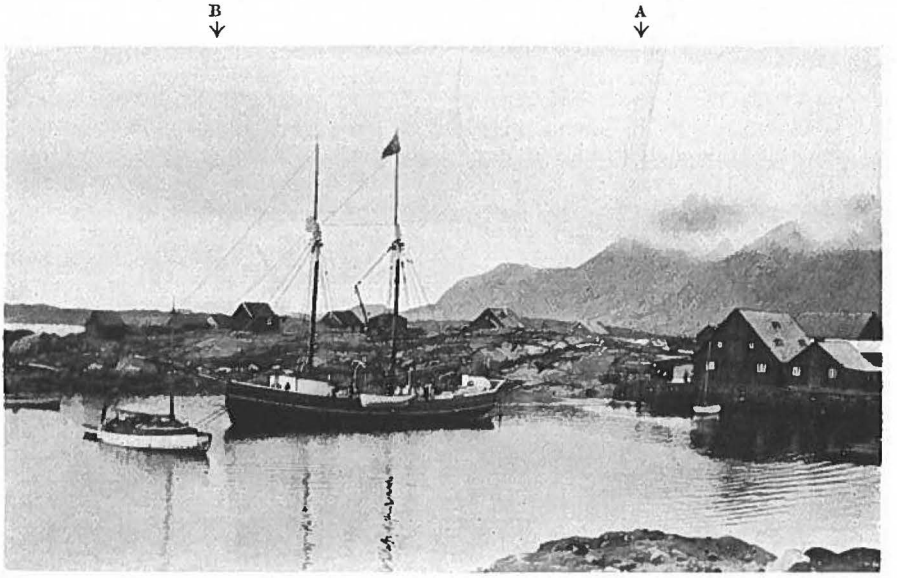


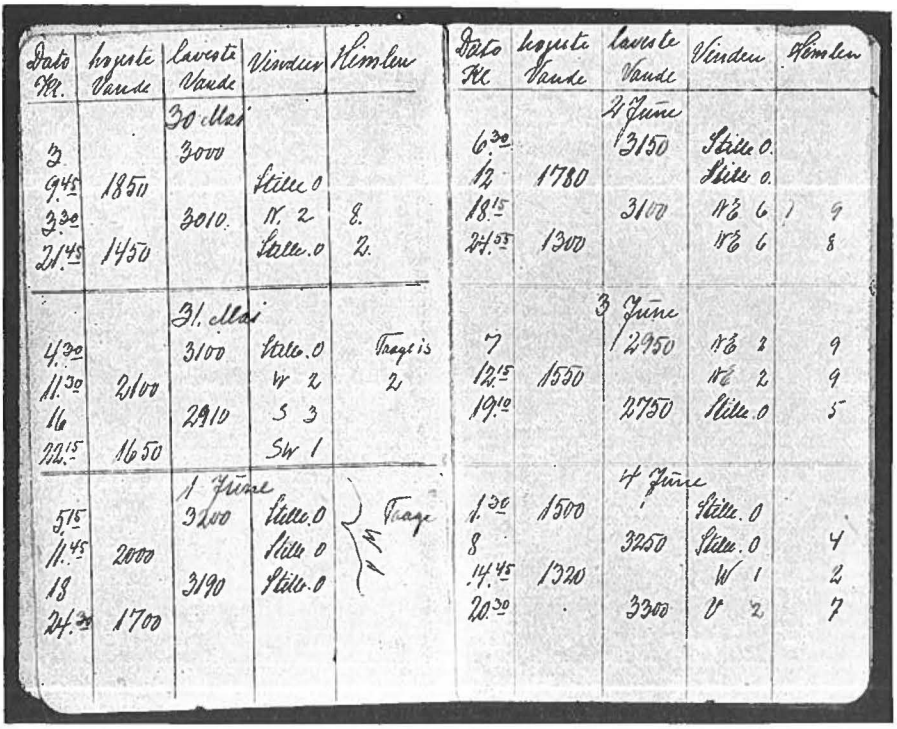
Fig. 1. The harbour in Nanortalik. The arrow "A" points down to the jetty and arrow "B" points to that place in the rock where the bolt is placed. The distance between the bolt and the staff is about 50 metres.
In the harbour is lying Dr. Knud Rasmussen's old Thule Ship "Søkongen" together with the Expedition's motor-boat "Dagmar".

II. Measurings by Tide Staff.

1932. As stated in the introduction, the measurings began at Nanortalik.

A tide staff was fixed at the jetty in the harbour. It was made of pine, about 4.25 metres in length, 10 cm. broad and 2.5 cm. thick, rounded off at the top and covered with a metal band. The divisions, which were reckoned from the rounded-off top (zero) were decimetres, the lines for which were cut a little down into the wood by a saw, to obviate their being washed out. In this manner, when reading, one formed an estimate of the centimetres. Wooden pegs were screwed in as metre marks, the whole staff was thoroughly painted and figures for each decimetre were painted on it. The staff was nailed in a perpendicular position to one of the posts on the south side of the jetty. It has stood here well protected and no changes in its height in a period of measurings have been able to be proved.

To carry out the tidal observations the Greenland Sealer Henrik Benjaminsen from Nanortalik was engaged, who accomplished this far from easy task with great devotion to duty and care. In order to simplify the measurings, it was decided to carry these out exclusively as observations of the extreme values and furthermore only in the day.



Dato Kl.	Højeste Vande	Laveste Vande	Vinden	Himlen
		30 Maj		
3		3000		
9.45	1850		Stille 0	
3.30		3010	N. 2	8.
21.45	1450		Stille. 0	2.
		31. Maj		
4.30		3100	Stille. 0	Tåge is
11.30	2100		W 2	2
16		2910	S 3	
22.15	1650		SW 1	
		1 Juni		
5.15		3200	Stille. 0	Tåge
11.45	2000		Stille 0	
18		3190	Stille. 0	
24.30	1700			

Dato Kl.	Højeste Vande	Laveste Vande	Vinden	Himlen
		2 Juni		
6.30		3150	Stille 0.	
12	1780		Stille 0.	
18.15		3100	NE 6	1 9
24.55	1300		NE 6	8
		3 Juni		
7		2950	NE 3	9
12.15	1550		NE 2	9
19.10		2750	Stille. 0	5
		4 Juni		
1.30	1500		Stille. 0	
8		3250	Stille. 0	4
14.45	1320		W 1	2
20.30		3300	V 2	7

Fig. 2. A photographic reproduction of the Observations Journal from Nanortalik in 1933.—The force of the wind is stated in the scale 0—12. The clouds in the scale 0—10.

The measurings were begun on the 6th of July and concluded on the 16th of October.

On the boat journey from the 7th to the 21st of October I stayed together with Dr. Knud Rasmussen for several days at Nanortalik. During that time a levelling was taken to decide the difference in the height between the zero point (top edge) of the staff and the G.G.U. bolt.

1933. Dr. Knud Rasmussen was from the beginning very interested in these tidal investigations, and therefore fully approved that the work on the same be continued and extended in 1933.

At Nanortalik the observations were already in operation on the 27th of May and were extended right down to the 26th of October.

The observer this time was the Greenland Colony-Hand (Kivfaq) Emil Sørensen who has carried out his task in the best possible way. The Greenlanders are very clever observers, and they carry out with great care and exactness such a restricted task as that of observing the extreme values of the sea level as compared with fixed points.

It can be mentioned in comparison that Gustav Holm let the hands,—the two Danish-Greenlanders, Johan and Henrik Petersen—undertake Tidal observations in 1883. As the leaders themselves in addition were present, the observations could be made, to a

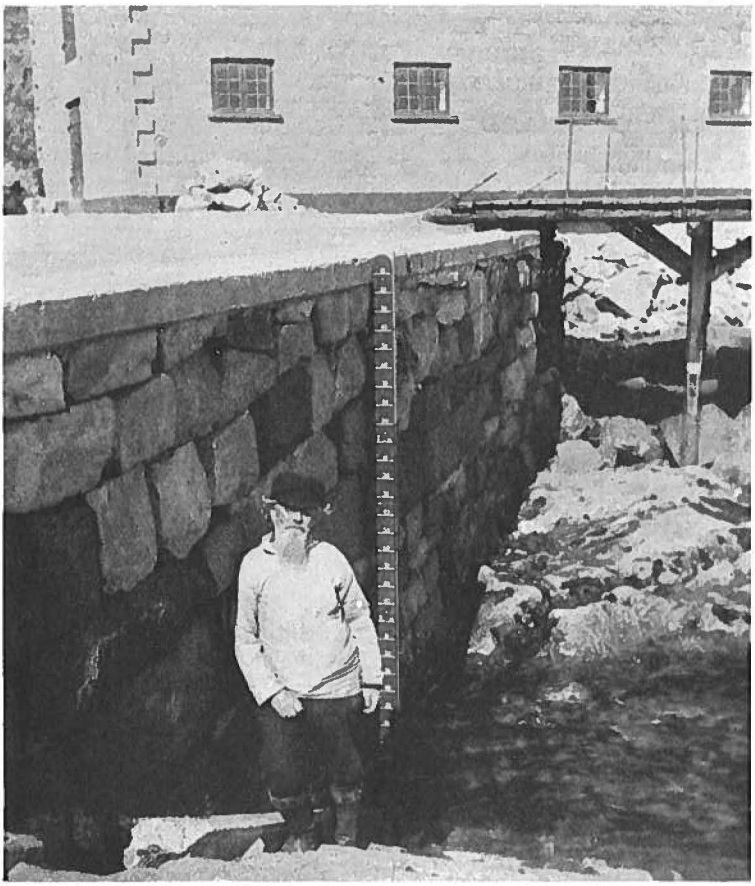


Fig. 3. Tide staff "A" in Julianehaab harbour. In the background, the inmost part of the jetty and behind, the big new stone warehouse "Nyboder".

certain extent, in a more satisfactory manner. See the photographic reproduction of the Observations Journal from 1884, page 39, Fig. 12.

The necessary levelling of the staff zero point was taken on the occasion of the Geodetic team passing Nanortalik on the outward and home journey from the East Coast.

At Julianehaab a tide staff of exactly the same type as described under Nanortalik 1932 was erected immediately on the arrival of the expedition at the colony. The tide staff ("A") was bolted to a heavy post

on the south quay wall in the harbour (Fig. 3), and has apparently stood here quite undisturbed.

The observations here were handed over to the young Dane P. Jensen Esq., B. A., Scientific Assistant with "Den danske Polaraars Expedition 1932—1933" to Julianehaab, and these measurings are, of course, characterised as having been carried out by a man competent and familiar with the task.

The measurings were begun on the 28th of June and concluded on the 9th of October.

As fixed points (bench mark) in land, two were chosen which are further described under "The Levellings", page 22.

Before and after the journey to the East Coast, the difference was decided between the tide staff zero point and the fixed points in land.

III. The Self-Registering Tide-Gauge.

The observations in Nanortalik as well as in Julianehaab were planned as observations of the extreme values of the sea level. We were well aware that this was far from the best method, but the resources of the expedition did not permit us to spare and leave behind a special team for taking more frequent measurings, the whole day through.

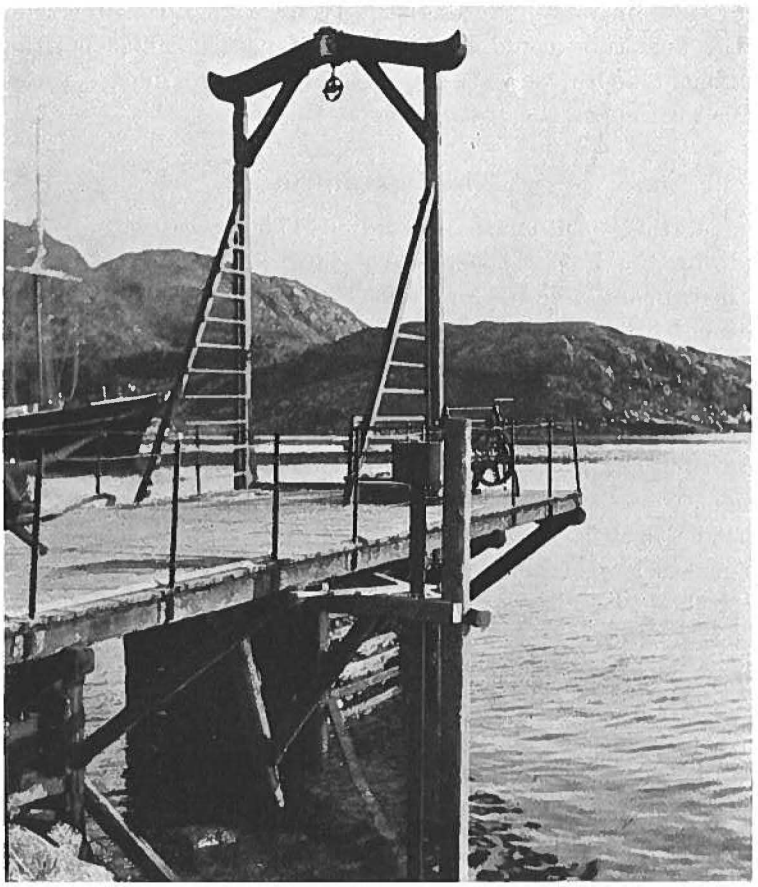
There arose with me, however, the natural wish for obtaining a more exact and quicker method for the determination of the mean sea level, which would be of great importance for future more systematic tidal observations in Greenland.

It is the task of an expedition to experiment and to find new ways, and such was the case here. The instance came to our assistance here inasmuch as my English collaborator, Michael Spender Esq., B. A., Engineer, (Oxford) on a previous expedition in which he had taken part, had undertaken tidal observations with a self-registering instrument which was still in the possession of The Royal Geographical Society of London. As it lay within the range of possibilities to get this instrument sent up as early as the same summer (1933), the case was laid before Dr. Knud Rasmussen who enthusiastically gave the idea his support and who, by telegraphic negotiation with the Society in London, had arrangements made for the loan and forwarding of the instrument up to Angmagssalik, from which place the expedition should then itself transport it to Julianehaab, and all this succeeded quite according to plan.

When the M/B. "Andræ" arrived at Julianehaab on the 4th of October 1933 from the East Coast, it had the Tide-Gauge onboard and the work of fixing it up in the harbour was at once commenced.

The Installation.

After a number of investigations and considerations, the ship jetty in Julianehaab harbour was considered as being the best suitable place for the placing of the float-tube. The place was not quite ideal, as the



↑

Fig. 4. The picture shows the jetty in Julianehaab harbour, with the extension on the south side. Inside the heavy perpendicular post is seen the float-tube (marked below with ↑) which carried the instrument at the top, covered by a square box.

harbour easily becomes filled with "pack-ice" and the jetty is in great use for discharging and loading, so that there was the danger that ice, vessels or goods could come to press the bridge out of its bed. This last-named, fortunately, did not happen, and further precautions were taken against this when fixing the float-tube, because the jetty did not come to bear the instrument but only support it in a horizontal position. Special blastings had also to be made in the sea bed, so as to get the tube so far down, that the float, even at the lowest possible

tide could move quite freely. All these technical difficulties were, however, overcome in the best way, thanks be to the great interest shown in the matter by Colony Manager P. Ibsen, together with the excellent work carried out by the two clever Greenland brothers John Høegh, Master-Smith and Pavia Høegh, Master-Carpenter.

An extension was made to the jetty by means of heavy timber to which the float-tube could be fixed in its perpendicular position and at a sufficient depth, and so Mr. Spender could commence the setting up and adjusting of the instrument itself.

The Instrument.

The portable Automatic Recording Tide-Gauge was designed by Dr. Rude for the U. S. Coast and Geodetic Survey. A full description of the instrument will be found in U. S. Coast and Geodetic Survey (Department of Commerce Serial No. 300) Special Publication No. 113, G. T. Rude: Portable Automatic Tide-Gauge, and a shorter account in the Geographical Journal, Vol. 79, March 1932, M. A. Spender: Tidal Observation on the Great Barrier Reef Expedition.

The photographs Figs. 4 and 5 adequately show the way the instrument works. In the tube above which the instrument stands, is a float. The float is a hollow brass cylinder, 3.25 inches in diameter and 15 inches long, tapered at the ends and weighted so that the top will float about 1 inch above the surface. The wire (bronze 0.0125 inch in diameter) which comes up from the float, runs into a helical groove on a drum inside which is coiled a watch-spring which maintains the wire in tension. The drum now rotates in correspondence with the movement of the float and this motion is further conveyed by a train of gears to the recording pencil, which in its turn moves over a cylinder carrying the record-charts and rotated by clock-work. The instrument is protected by a strong galvanized iron cover.

As a special precaution in this case, the oil was removed from the clock and graphite substituted. Furthermore, a canvas-case was made to tie over the instrument housing, and prevent snow and ice from entering.

The Observations.

The instrument was inspected, circumstances permitting, once daily when the true values of time and height were written against a mark on the record made at the instant of inspection. Time (chart No. 0 excepted) is Greenwich Mean Time, obtained daily from wireless signals. Height (in absolute value) was read from a special staff[1]), which was

[1]) Staff "B". prepared in the same way as that staff mentioned under Nanortalik 1932, only with the dividing figures (in English feet) beginning from the bottom.

attached to the vertical pile outside the float-tube. This mark (the 13 feet) has been levelled into the trigonometrical system, so that readings on this staff are related directly to a known bench mark on shore.

The height scale for the charts is in English feet; the time scale in mean solar hours. The instrument was set in motion using the gears

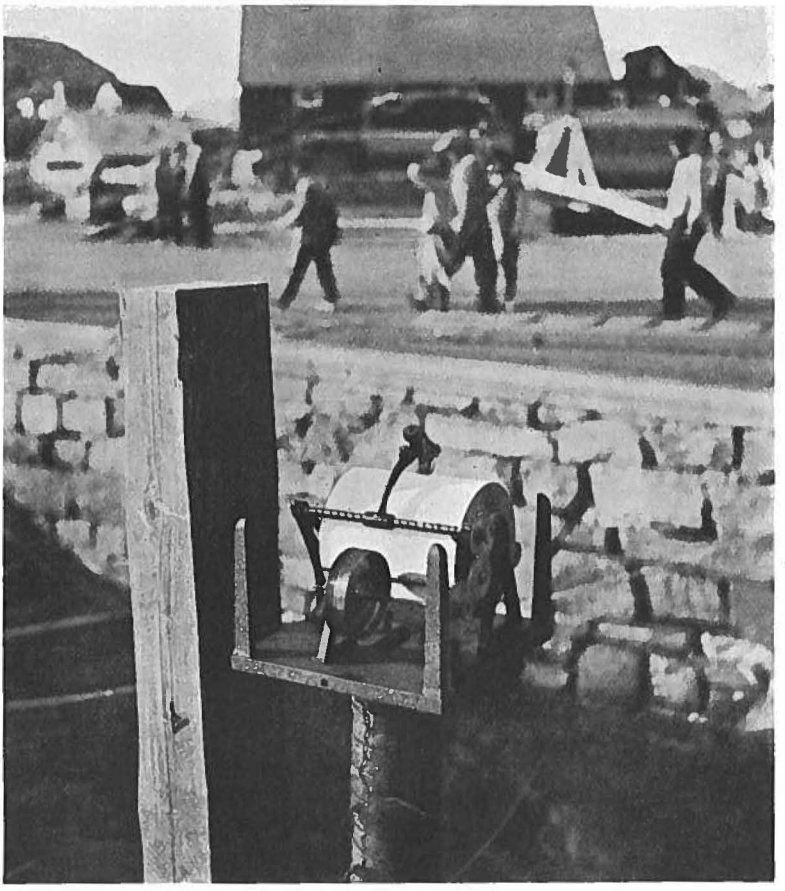


Fig. 5. The instrument is uncovered and the drum is visible and a part of the wire rolled on. One can furthermore see the big cylinder with the record-chart and stylus which traces the movements of the float to the paper.

corresponding to a maximum range at 12 feet. Since the charts are graduated to correspond with a maximum range of 6 feet, the readings on the height scale are one half of the true reading.

The instrument has been readjusted only in those cases where divergence from correct time or height was considerable, and such cases can clearly be seen on the records.

The pencil record was legible throughout. In stormy weather when the big sea would have made it impossible with a fair certainty to make

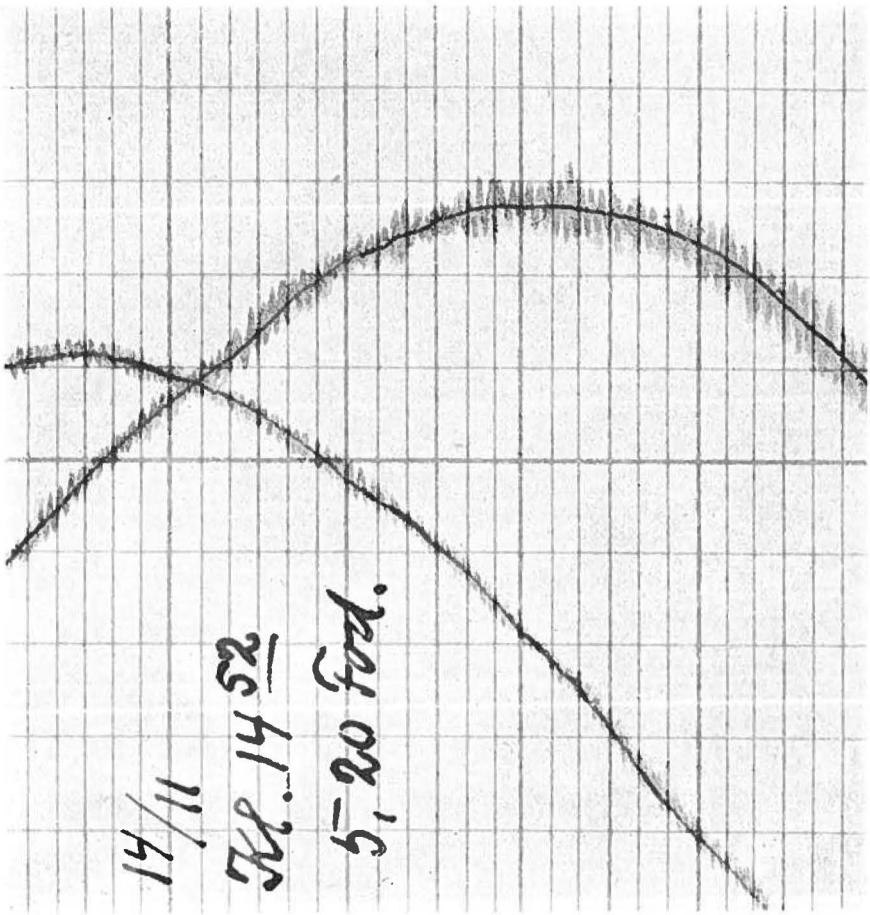


Fig. 6. An enlarged section of the record chart from the 12th November 1933 (the topmost curve). The weather at the time in question—5 hours—was calm, with wind 1 from the North and temperature about —1° C. The sea has nevertheless been very stormy, which cannot be attributed to local reasons.

measurings on the tide staff a slight broadening of the recorded line can be seen, and the final curve has been able to be drawn with great certainty. See Fig. 6.

The measurings commenced the 10th of October and were continued until the 15th of July 1934. The recordings were only used, however, until the 30th of June 1934.

The supervision of the instrument was entrusted to the care of Orla Andersen, Clerk at the Julianehaab Colony, and he has fulfilled this task in a praiseworthy manner.

On his return to Denmark in the spring of 1934, another of the Colony clerks undertook the task, but he had the misfortune during

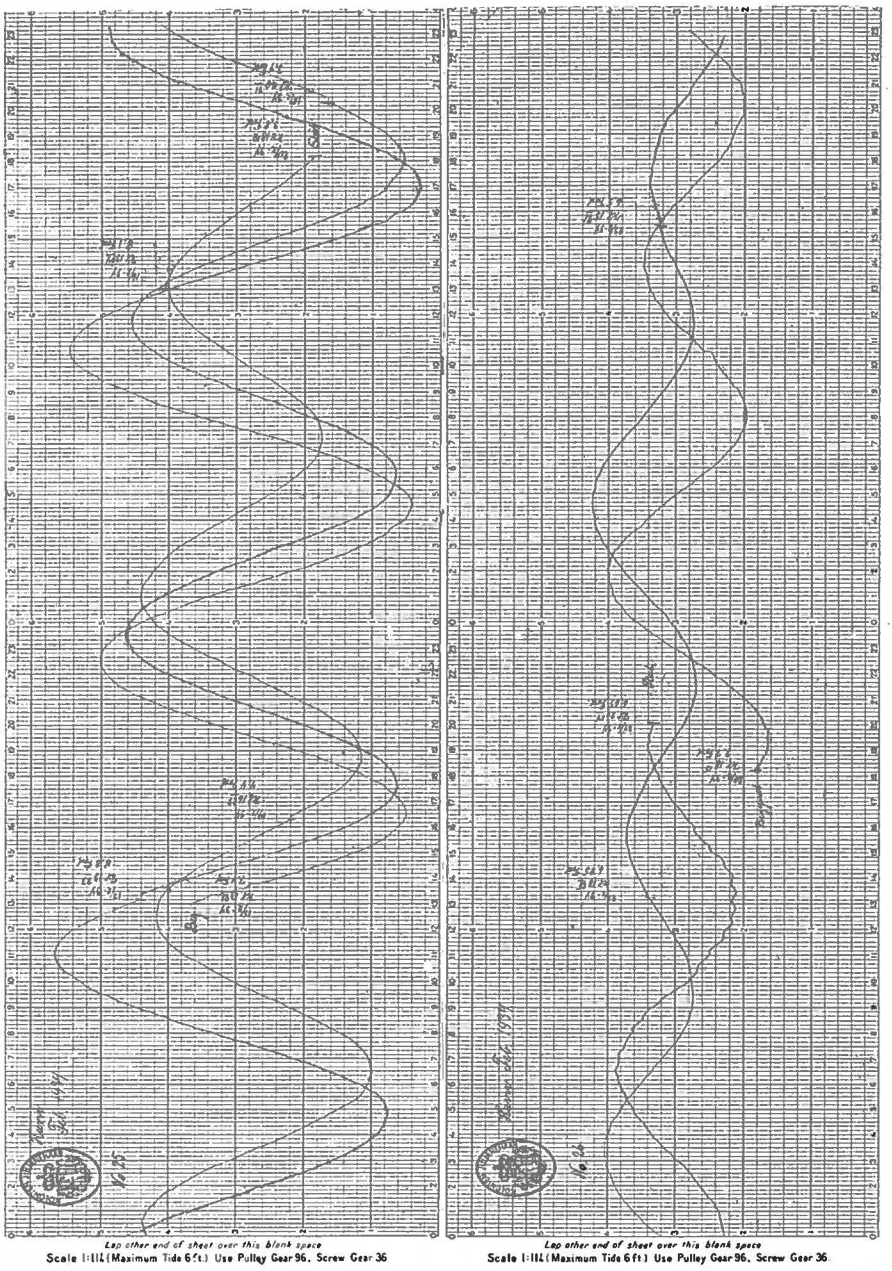


Fig. 7. Reduced (one third size) reproduction of tidal graphs.
No. 25 comprising the period $^{15}/_{2}$—$^{20}/_{2}$ 1934 and
- 26 — - — $^{20}/_{2}$—$^{24}/_{2}$ 1934

In the first period, the direction and force of the wind on the 15th February was N.W. 5 and the temperature —3° C. For the remainder of the period there was calm, with a fall in temperature up to —9° C. In the second period, there was calm with temperature fluctuations from —1° to —10° C.

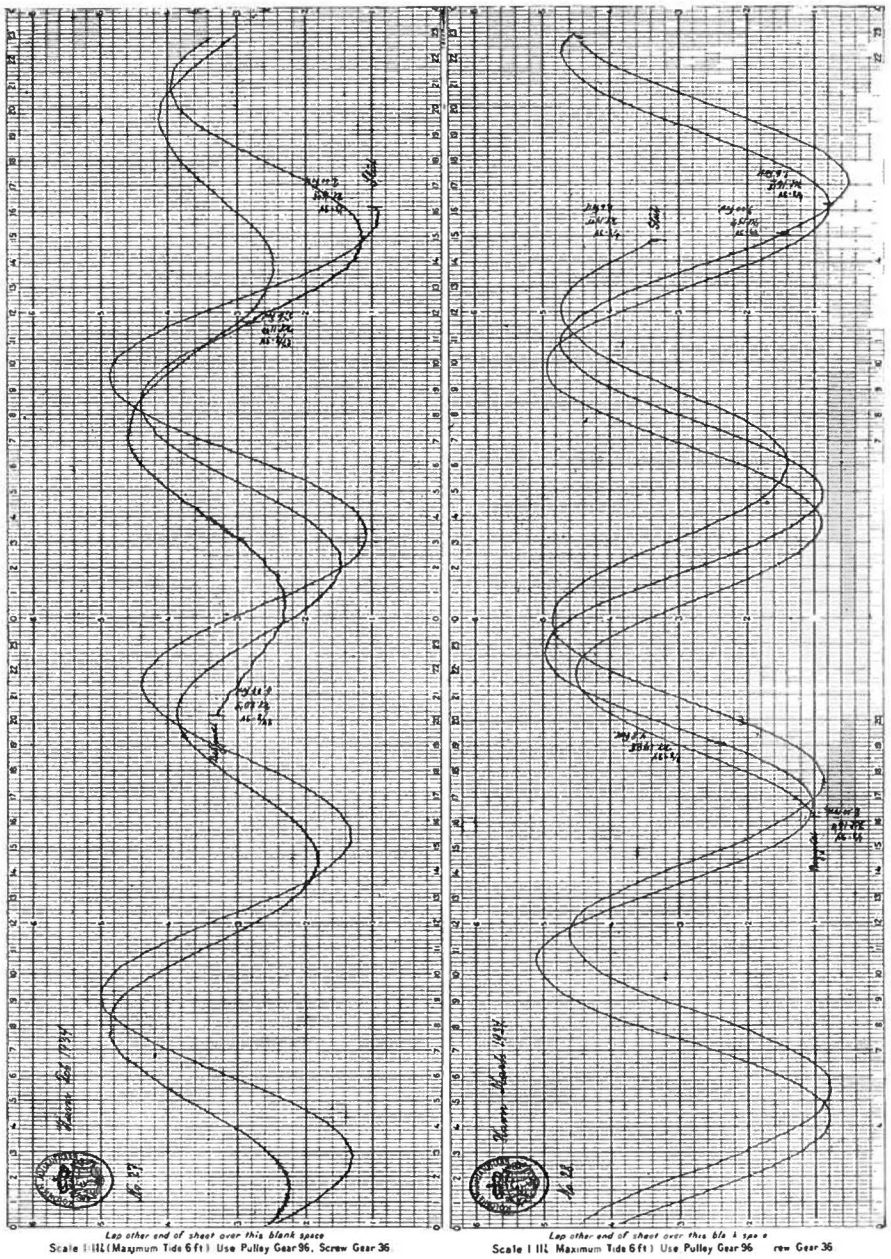


Fig. 8. Reduced (one third size) reproduction of tidal graphs.

No. 27 comprising the period $^{24}/_{2}$—$^{1}/_{3}$ 1934 and
- 28 — - — $^{1}/_{3}$—$^{6}/_{3}$ 1934.

During both periods it was mostly calm weather, degrees of frost fluctuating from —2° to —12° C.

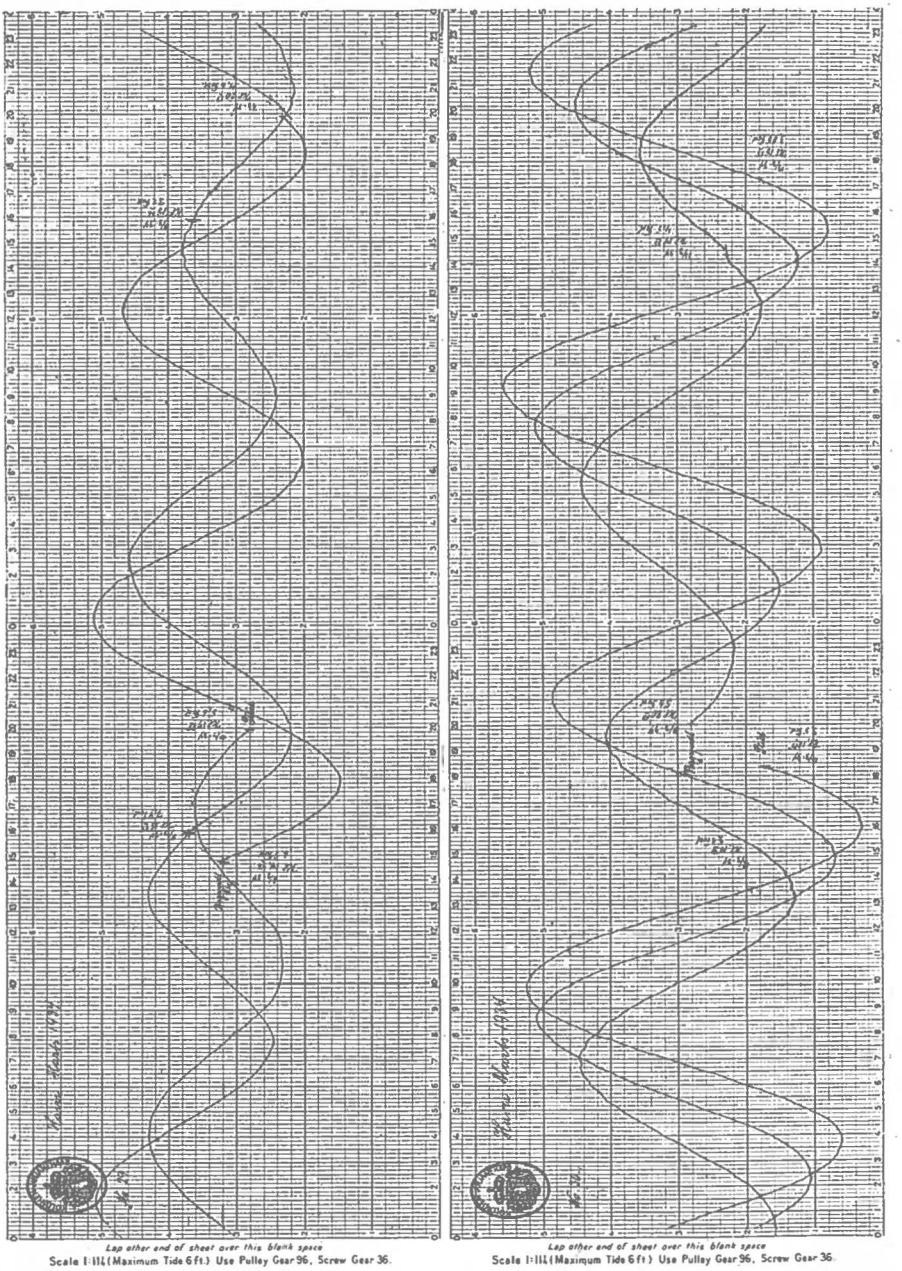


Fig. 9. Reduced (one third size) reproduction of tidal graphs.

No. 29 comprising the period $^{6}/_{3}$—$^{10}/_{3}$ 1934 and
- 30 — - — $^{10}/_{3}$—$^{16}/_{3}$ 1934.

During both periods the weather was very calm, but the temperature had been subject to some fluctuations. During the first period from —1° to +3° C. In the second period, the frost returned with a force of up to —10° C.

a change over, to disturb the clock movement, so that the measurings had to be suspended long before the time, and the Expedition did not, therefore, get its great wish fulfilled of obtaining continuous tide records for a whole year.

On the whole, the setting up of the instrument has worked excellently. That which one was, of course, most concerned about was as to how the instrument—especially the float—would work in the winter, when the harbour was often frozen over, but that also was managed very well, so that even "new ice" on the water and the temperature at about —20° C. did not cause a stoppage of the measurings. During more severe frost, petroleum was poured into the tube as an experiment, with good results.

It appears, however, that the clock movement has been affected to some extent by fluctuations of temperature, so that it lost at night, (up to 10 minutes) which loss was regained in the day when the sun warmed the instrument. This is of course unfortunate, but no changes in the insulation of the instrument were made.

In all, 47 tidal graphs were brought home.

To illuminate the whole work are added six tidal graphs in reduced reproduction, which together represent tidal movements during a period of about six weeks. (Figs. 7, 8 and 9).

IV. The Levelling.

Description of the Bench Marks.

In Nanortalik:—

That vertical iron bolt driven down into the rock by Holm and Garde in 1883 at the old Observation House. In the rock, at the bolt, is cut out "G.G.U.". The slightly rounded-off top of the bolt gives the levelling point itself.

In Julianehaab:—

Two bench marks were established in 1933.

Point I: In the big warehouse called "Nyboder", built of quarried granite and situated in Julianehaab harbour. Close to the north-west corner of the warehouse is bolted a mark-plate with the inscription: "Geodætisk Institut Danmark". In the centre of the horizontal copper bolt is cut a little hole. The middle of this hole gives the levelling point itself. See Fig. 10.

Point II: On the south side of the Colony Manager's garden in Julianehaab. On the vertical surface of the exposed bed rock, a heavy

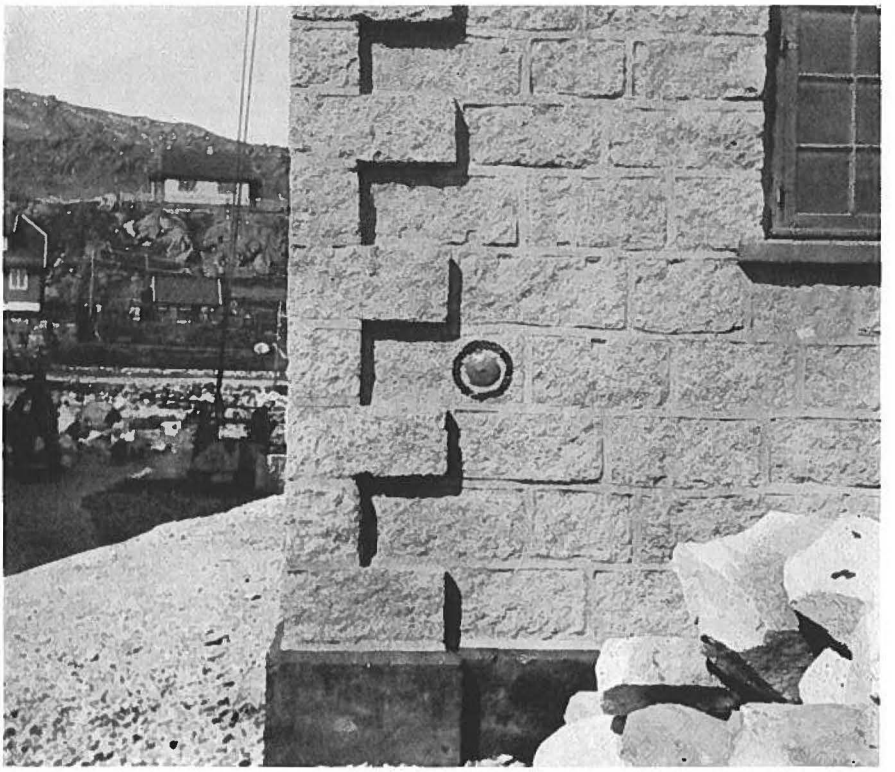


Fig. 10. Levelling point I at "Nyboder", Julianehaab harbour. A ring is painted round the plate.

brass bolt is driven into the rock. The top edge of this round horizontal bolt gives the levelling point itself.

To afford further certainty, a Geodetic Institute mark-plate has been bolted under this bolt. The distance from the top edge of the main bolt to the middle (little hole) of the plate bolt is 67 mm. See Fig. 11.

The Levelling and the Result.

The difference in height between the staff zero points and the bench mark have been measured in the usual manner by purely geometrical levellings, setting up in the exact centre and by measuring to the divided wooden staffs.

By reason of the lack of proper levelling outfit, the difference in height in Nanortalik between the G.G.U. bolt and the tide staff, was deduced by measuring the height angle and in a direct manner the horizontal distance between the G.G.U. bolt and the tide staff.

A summary is given below of the total results of the observations:

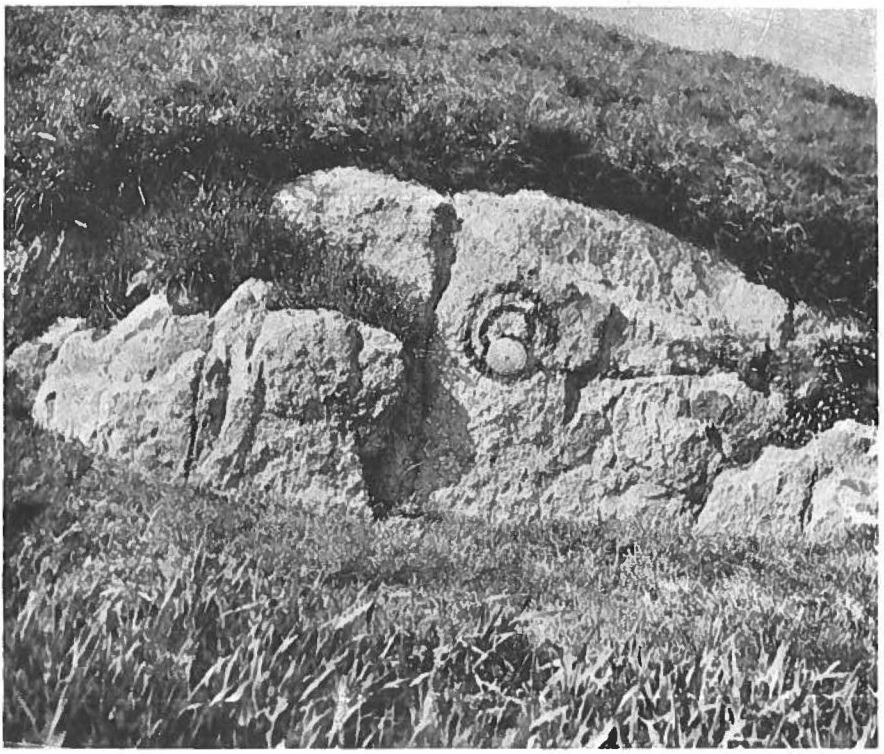


Fig. 11. Levelling-point II in the Colony-Manager's garden at Julianehaab. Round the main bolt are painted two concentrical rings.

In Nanortalik:

G.G.U. bolt over staff zero point.

Measured value.			Used value.
$^{16}/_{10}$ 1932	+ 3.784 m.	± 0.003 m.	+ **3.784** m.
$^{1}/_{7}$ 1933	+ 3.797 m.	± 0.001 m.	+ **3.795** m.
$^{30}/_{10}$ 1933	+ 3.794 m.	± 0.001 m.	

In Julianehaab:

Bolt I over staff zero point. ("A")

$^{28}/_{6}$ 1933	+ 1.434 m.	± 0.002 m.	+ **1.4325** m.
$^{8}/_{11}$ 1933	+ 1.431 m.	± 0.001 m.	

Bolt II over staff zero point. ("A")

$^{28}/_{6}$ 1933	+ 1.928 m.	± 0.001 m.	+ **1.928** m.

On the 28th of June 1933, it was discovered by levelling direct between Bolt I and Bolt II for further control, that Bolt II lies + 0.496 m (± 0.001 m) higher than Bolt I.

All these observations have been carried out by C. Gabel-Jørgensen.

In connection with the automatic tide-gauge, the 13 feet mark on the special tide staff B was levelled with the following result:

Bolt I over the 13 feet mark. ("B")
$^{8}/_{11}$ 1933. + 1.614 m.

Furthermore, Assistant E. Vedel, Julianehaab, has repeated this levelling on the following occasions:

May	1934	+ 1.621 m.
June	—	+ 1.617 m.
July	—	+ 1.619 m.
Aug.	—	+ 1.620 m.
Sept.	—	+ 1.616 m.
Oct.	—	+ 1.614 m.

The mean value of these observations is

1.617 ± 0.001 m

The somewhat fluctuating results must surely be considered as general observational errors, for which reason the total measurings from 1933 and 1934 are epitomised to the value used above.

The measurings taken on the 7th Thule Expedition have given the following values for the height of fixed points above mean sea level:

Nanortalik: G. G. U.-Bolt **6.157** m. ± 0.0093 m. (See p. 40).
1933.4

Julianehaab: Bolt I **3.725** m. (See p. 31).
1934.0

„ Bolt II **4.220** m.
1934.0

Concerning the variation of the heights see p. 42.

These tidal observations appertaining to the 7th Thule Expedition are booked as follows:—

Volume 1. Tides. 6th July—16th Oct. 1932. Nanortalik.
— 2. Tides. 27th May—26th Oct. 1933. Nanortalik.
— 3. Tides. 28th June—9 Oct. 1933. Julianehaab.

which three journals contain all the extreme readings from the tide staves.

There are 47 tidal graphs from the Automatic Recording Tide-Gauge.

The levelling is to be found entered in the Journals:—

(1) 7th Thule Exp. 1932. No. 10, pages 41—47 and
(2) Triangulation Grønland. No. 39, pages 18—21 and 131—133.

The whole of the material is in the custody of the Geodetic Institute, Copenhagen.

In conclusion, I should like to express my thanks to the many who in Greenland have contributed to the successful carrying out of the whole of this work.

I thank those colleagues, Greenlandic and Danish, who have carried out a conscientious and competent work as observers, the results of which now appear here. In like manner, I tender my thanks to the Management of Julianehaab Colony and the Nanortalik Settlement, together with the clever artisans there for their willingness and the technical ability with which they have assisted the expedition.

And finally, my special thanks to Michael Spender Esq., Engineer, my Expedition-fellow, whose idea it was regarding the Automatic Recording Tide-Gauge and who, by reason of his intimate knowledge of the working of this instrument, has such a great share in the result.